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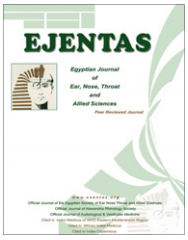

ORIGINAL ARTICLE

Nasal swab as an alternative to bronchoscopic lavage for identification of pathogenic organisms in patients with chronic sinusitis concomitant with chronic bronchitis exacerbations

Hassan Aref [a], Ahmed Fathy [b,*], Manal Mokhtar [c]

[a] *Pulmonology Department, Cairo University, Egypt*
[b] *ENT Department, Cairo University, Egypt*
[c] *Microbiology Department, Ain Shams University, Egypt*

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KEYWORDS

Rhinosinusitis;
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Abstract *Background:* Cigarette smoke is the most important risk factor for COPD. It has a destructive potential for nasal mucosa. There is a correlation between upper airway inflammation and COPD exacerbation suggesting that the nose may be used to model the lung in COPD, but the relationship between organisms colonizing the upper and lower respiratory tracts is not clear.
Aim of work: The aim of this study was to identify the individual bacterial cultures in nasal swab and BAL and to correlate these microbiological data in patients with CRS and concomitant COPD exacerbation.
Subjects and methods: Sixty-three patients with CRS during exacerbation of COPD and 10 control subjects with CRS and normal lower airways with similar age and sex distribution were recruited

Abbreviations: COPD, chronic obstructive pulmonary disease; CRS, chronic rhinosinusitis; BAL, bronchoalveolar lavage; FEV1, forced expiratory volume in first second; FVC, forced vital capacity.

* Corresponding author. Tel.: +20 9660540534133.
E-mail address: ahmedfwattar@hotmail.com (A. Fathy).

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for the study. Pulmonary function and paranasal sinuses CT examinations were performed together with endoscopic and clinical assessment. Endoscopic middle meatal swab and BAL were done to all subjects. All the specimens were examined for aerobic and anaerobic bacteria.

Results: Nasal swab cultures revealed 49.2% Gram positive organisms, 34.9% Gram negative organisms, and anaerobes 15.9%, BAL cultures resulted in 44.5% Gram positive organisms, 46% Gram negative organisms, and anaerobes 9.5%. *Streptococcus pneumoniae* was predominant in both nasal swab and BAL (25.3% and 26.9%, respectively) followed by *Staphylococcus aureus* (23.8% and 17.4%) *Moraxella catarrhalis* (15.8% and 20.6%), haemophilus influenza (14.2% and 19%) and *Pseudomonas* aeruginosa (4.3% and 6.3%). Matched organisms between upper and lower respiratory tract cultures were seen in 41 (65%) subjects.

Conclusion: Aerobic bacteria were the predominant organisms cultured from both upper and lower airways in chronic sinusitis patients with acute exacerbation of chronic bronchitis. The matched pattern of microorganisms cultured concomitantly from upper and lower airways, may suggest that nasal swab can be used as a non-invasive tool to predict lower airway pathogens.

1. Introduction

Cigarette smoke is the most important risk factor for COPD. It has a destructive potential for nasal mucosa, it is a cause of the pathological signs of mucosal inflammation,[1] it may cause several nasal symptoms,[2] impairment of mucociliary function,[3] and other changes.[4] These changes may even happen with second hand smoking.[5] *Chronic rhinosinusitis* is a group of disorders characterized by inflammation of the mucosa of the nose and paranasal sinuses of at least 12 weeks duration.[6]

Exacerbations of chronic obstructive pulmonary disease (COPD) were regarded as having a little impact on the course of COPD. In the last decade, new research methods have been applied to this question that have led to a better delineation of the contribution of bacterial infection to exacerbations of COPD.[7] Much of the morbidity, mortality, hospital admission, and health care cost in COPD relate to episodes of acute COPD exacerbations.[8]

Interactions between the upper and lower airways have been extensively studied in patients with asthma. In contrast, little is known about possible upper airway involvement in COPD patients, in whom cigarette smoke provides the pan-airway exposure in contrast to the allergen stimulation of allergic disease. Recently studies pointed to the correlation between upper and lower respiratory affection and related severity of upper airway involvement to that present in the lower airway, suggesting that the nose may be used to model the lung in COPD.[9]

There is no universally accepted definition of an exacerbation of COPD. The typical symptoms of exacerbation include breathlessness, cough, increased sputum production and purulence, wheeze and chest tightness. Although usually clinicians have little difficulty in diagnosing an exacerbation of COPD, establishing a universally accepted definition for epidemiological or interventional studies has proved difficult. The most widely used definition has been symptom-based.[10]

The predominant mechanism of bacterial exacerbation in COPD appears to be acquisition of new strains of bacterial pathogens from the environment that are able to establish infection in the tracheobronchial tree in COPD because of compromised innate lung defenses.[11] Potential pathways by which bacteria could contribute to the pathogenesis of acute exacerbation of COPD include: primary infection of the lower airways, secondary infection of the airways after an antecedent viral infection, and bacterial antigens inducing bronchial hyperreactivity and eosinophilic inflammation, and as the upper airways are commonly affected by chronic rhinosinusitis in acute exacerbations, there are no studies specifically examining interrelationships between bacterial pathogens in the upper and lower airways.

An exacerbation associated with purulent sputum production will be associated with a large bacterial load while an exacerbation associated with cold or upper respiratory symptoms will be viral in origin.[12]

Sputum culture was the mainstay of bacterial pathogen identification in COPD exacerbations. Sputum is expectorated and then subjected to microscopy and culture. A direct causal relationship between bacteria isolated from sputum and exacerbation remains unproven because this technique is limited by difficulty in expectoration, potential contamination with upper airway secretions, and the presence of lower airway cells, which can lead a pathologist to consider a good sample contaminated.

A further complication is that approximately 20–40% of patients with COPD will have positive cultures when clinically stable[13] thus, identification of a bacterial pathogen on standard sputum culture does not distinguish between preexisting colonization and new infective agent. Bronchoscopy, biopsy, and bronchoalveolar lavage (BAL) can be performed safely in patients with COPD, including those with severe disease, provided careful assessment is performed and guidelines are adhered to.[14]

2. Patients and methods

Patients with chronic bronchitis exacerbations and chronic rhinosinusitis (CRS) entered in this study. They all had chronic productive cough for more than 3 months for two consecutive years. The patients included in the study either had mild or moderate airway obstruction and with irreversible or partially reversible airway obstruction. COPD was defined as a post-bronchodilator forced expiratory volume in one second (FEV_1) to forced vital capacity ratio $< 70\%$ and a $ß_2$-agonist reversibility on predicted FEV_1 of $< 15\%$ or 200 ml. Exacerbation was confirmed by the

worsening of at least one of the three cardinal symptoms of exacerbation: dyspnoea, sputum volume and purulence.

All patients have chronic rhinosinusitis as proved by at least 3 months of symptoms of facial pain or pressure, nasal obstruction or blockage, nasal discharge or purulence or discolored postnasal drainage, hyposmia or anosmia. Chronic rhinosinusitis was confirmed by the presence of middle meatus secretions seen at the nasal endoscopy and paranasal sinuses opacity seen at coronal CT scan cuts according to Lund and Mackay scoring system, patients with deviated nasal septum which impairs the visualization of middle meatus were excluded from the study. Exclusion criteria included other causes of chronic cough and expectoration, such as bronchiectasis, tuberculosis, lung cancer, occupational or other exposure to substances known to cause lung disorders, congenital or acquired systemic immunodeficiency; therapy with antimicrobial agents within 3 weeks before entry into the study, and CO_2 retention ($Pco_2 > 45$ mmHg) or evidence of cor pulmonale. Patients with severe irreversible airway obstruction were excluded from the study because of safety issues.

In total, 63 patients were recruited for the study and 10 subjects with CRS and normal lower airways were taken as a control group. Patients were recruited by a selection of patients having chronic rhinosinusitis during chronic bronchitis exacerbation. At recruitment, patients' daily respiratory symptoms, smoking history, COPD exacerbation history and drug history were recorded. Height and weight were measured, in addition to baseline lung function and reversibility to $ß_2$-agonists was measured after inhaling 400 μg salbutamol from a metered-dose inhaler. The ethics committee of the hospital approved the study, and all patients gave an informed consent. Patients recruited to this study were subjected to middle meatal swab and bronchoalveolar lavage in same sitting, samples were sent for aerobic and anaerobic bacteriological cultures.

2.1. Middle meatus swab

The middle meatus swab for bacterial culture was done with the patient in a sitting position, cotton containing vasoconstrictor (oxymethazolin) and an anesthetic (4% cocaine) was placed along the lower nasal turbinate for 5 min. Nasal endoscopy was performed with 30° wide angle, 2.7 mm rigid endoscope (Storz). A swab was passed into the middle meatus under endoscopic guidance and directed to the site of mucopurulent discharge. In those patients who had previously undergone sinus surgery, the swab was passed directly into the maxillary or ethmoid cavity. The swab was left in place for few seconds until moistened and then it was carefully removed. The samples were collected using two swabs per patient. All specimens for aerobic culture were obtained with a collection swab (BBL Culture Swab [Cat #220099], for anaerobic culture specimens were collected by *BD BBL Collection and Transport Systems, BBL Vacutainer* [Cat #236500]. The swabs were transferred to Stuart transport media and sent immediately for aerobic microbiological examination. The Vacutainer provides a moist anaerobic atmosphere for anaerobic bacterial culture.

2.2. Bronchoalveolar lavage

Fiberoptic bronchoscopy (model 1T10 bronchoscope; Olympus; Tokyo, Japan) with inspection of bronchial mucosa and of all segmental bronchi was performed in all patients. Bronchoalveolar lavage was performed by instilling 150 ml of sterile saline solution, in three 50-ml aliquots, through the fibreoptic bronchoscope wedged into the lobe selected for lavage (usually middle lobe or lingual). The lavage fluid was then recovered by gentle suction after each aliquot had been infused. The total amounts of fluid recovered were recorded.

2.3. Blood sample

A 5-ml sample of venous blood was collected into a sterile Vacutainer, centrifuged, and analyzed for complete blood picture, ESR and CRP.

2.4. Microbiological examination

The samples were forwarded to the laboratory at most 1 h after collection. Quantitative cultures were processed according to the standard laboratory protocol and Gram staining was performed on 1 drop of undiluted BAL fluid. All samples were mechanically liquified and homogenized by vortexing for 1 min with glass beads, centrifuged at 3000 rpm for 10 min. The samples were then serially diluted in 0.9% sterile saline solution with final dilutions of 10^{-2}, 10^{-3} and 10^{-4} according to the standard laboratory protocol. All swabs and BAL specimens plated as following.

2.4.1. For aerobic bacterial cultures

The specimens were inoculated directly onto Mac Conkey, 10% Sheep Blood agar media, Chocolate Bacitracin blood agar, Gentamycin blood agar, Mannitol salt agar and Thayer Martin (contain vancomycin to inhibit Gram positive bacteria and colistin to inhibit Gram negative bacteria). All plates were incubated at 37 °C for 24 h in the aerobic and CO_2 incubators depending on the media inoculated. If there was no bacterial growth, the medium was re incubated for 24 h more before it was released as negative.[15]

2.4.2. For anaerobic bacterial cultures

The specimens were inoculated on Sheep Blood agar, Neomycin anaerobic blood agar, Bacteroide Bile Esculine agar, Brain Heart Infusion agar and tube of thioglycollate broth as soon as possible. All plates were placed in an OXOID GasPak jar (2.5 l) with AnareoGen (Oxide AN 23) for rapid generation of anaerobic environments which was essential for rapid growth of fastidious organisms. Incubate at 35 °C for 48 h. The thioglycollate broth tubes were incubating at 35 °C. All organisms isolated were subcultured on blood agar media and incubated aerobically and anaerobically. We selected all strict anaerobes. If direct cultures were negative after 48 h incubation, we repeated subcultured from thioglycollate broth on fastidious anaerobe blood agar and neomycin agar. All plates were incubated anaerobically for an additional 48 h. If cultures were negative, report out as negative after 4 days incubation. If no growth was detected after 96 h, the original plates were reported to be negative.[15,16]

We defined our cases as having microbiological evidence of bronchoscopic BAL samples that grew one or more respiratory pathogens at a diagnostic threshold of $\geqslant 10^4$ cfu/ml[3]. Growth below the threshold was assumed to be due to

Table 1 Clinical characteristics of patients with chronic rhinosinusitis during COPD exacerbation (63 patients) compared with a control group of patients with chronic rhinosinusitis (10 patients) without lower respiratory tract affection.

Clinical characteristics		Chronic rhinosinusitis with COPD exacerbation (n = 63)	Chronic rhinosinusitis (n = 10)
Age, yr	Maximum	71	65
	Minimum	39	38
	Mean ± SD	54 ± 7	48.5 ± 7.8
Sex	Males	43	7
	Females	20	3
Smoking status	Smokers	41	4
	Ex-smokers	22	0
	Non-smokers	0	6
Smoking pack/year	Maximum	50	22
	Minimum	14	0
FEV1% predicted	Maximum	78	102
	Minimum	50	82
	Mean ± SD	64 ± 6.3	88 ± 6.9
FEV1/FVC ratio (%)	Maximum	69	88
	Minimum	47	75
	Mean ± SD	59 ± 6.3	81.5 ± 3.7
WBC $\times 10^3$ μl^{-1}	Maximum	20.5	9.4
	Minimum	5.8	4.1
	Mean ± SD	13.2 ± 2.8	5.85 ± 1.7
Neutrophil count (%)	Maximum	96	77
	Minimum	47	48
	Mean ± SD	76 ± 12.0	55.5 ± 8.4
CRP mg/dl	Maximum	176	11
	Minimum	9	4.2
	Mean ± SD	30 ± 47	7.1 ± 2.1

colonization or contamination. For Gram stain results the thresholds for the diagnosis were as follows: >10 polymorphonuclear neutrophils (PMN)/high-power field (HPF), 1 bacteria/oil immersion field (OIF), presence of intracellular bacterial inclusions. All organisms were identified by standard bacteriological methods. After isolation and confirmation of Gram positive and negative bacteria by Gram stain, Potential pathogens present at $\geqslant 1 \times 10^4$ CFU/ml were considered clinically significant,[17] and identification as following:

2.4.3. Biochemical micro tests

- API 20E test (bioMérieux, Marcy l'Etoile, France), which was used to identify Gram-negative bacteria of Enterobacteriaceae family and other fermenting Gram-negative rods and API 20NE test (bioMérieux, Marcy l'Etoile, France) to identify non-fermenting Gram-negative rods.
- GP2 MicroPlate test (BIOLOG, Inc., Hayward, CA, USA) were used to determine Gram-positive bacteria. It was identified by standard methods, including Gram stain, measurement of catalase production, results of a slide agglutination test (Staphaurex; Murex Biotech Limited), and results of a tube coagulase test .The tube coagulase test, plasma was inoculated with suspicious colonies and examination of tubes after incubation for 4 h and 24 h. Oxacillin resistance for each *Staphylococcus aureus* isolate was determined by measuring growth on Mueller Hinton agar (MH) containing 4% NaCl and 6 μg/ml oxacillin, as recommended by the Clinical Laboratory Standards Institute.[18] Other identification tests as Streptex rapid latex test (Remel), Streptex for use in the qualitative identification of the Lancefield group of *Streptococci*, optochin disk (Oxide) for identification of *Streptococcal pneumoniae*, factor X, V, & XV discs for identification of *Haemophilus* spp. were also used as well according to types of isolates.

2.4.4. Carbohydrate utilization tests

- Cystine-trypticase agar (CTA) basal medium with phenol red containing filter sterilized glucose, maltose, lactose, and sucrose was used to identify the classically pathogenic *Moraxella catarrhalis*. A heavy inoculum of a pure culture, no more than 24 h old, was stab inoculated into the upper half of the CTA. Tubes are incubated without added CO_2 at 35°C. After 24 h the upper portion of the tubes are observed for acid. No acid from any of the four sugars.[15]
- All anaerobic microorganisms grown were identified by standard bacteriological methods. It was identified by its colonial and microscopic morphology, growth on selective media, oxygen tolerance, and biochemical characteristics. These included sugar fermentation, bile solubility, esculin,

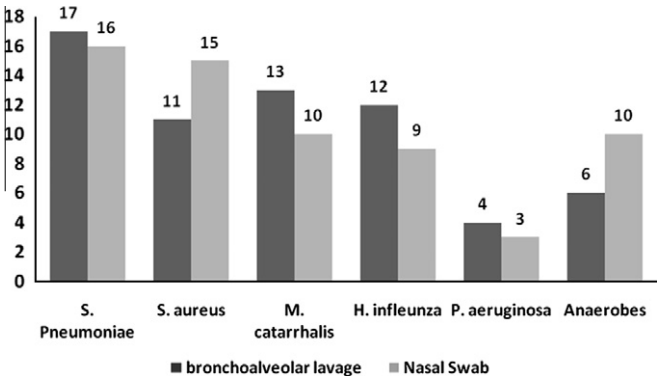

Figure 1 Comparison of cultured organisms from bronchoscopic lavage to nasal swab samples during COPD exacerbation from patients with combined chronic rhinosinusitis and COPD.

starch, and gelatin hydrolysis, casein and gelatin digestion, catalase, lipase, lecithinase, and indole production and nitrate reduction, its identification was made with the use of the API system for anaerobic germs (Bio Merieux, France).[16,19]

2.4.5. Automated identification systems

VITEK2 (bioMérieux, Marcy l'Etoile, France), had been introduced. VITEK 2 cards (NGPC; bioMérieux, REF. 21341) for identification of Gram-positive cocci and (GN bioMérieux, REF.21342) for identification of Gram-negative bacilli were used. Suspensions were prepared by emulsifying purified bacterial isolates in 0.45% saline to the equivalent of a 0.5 McFarland turbidity standard. Suspensions for the comparative identification method were made according to the manufacturer's recommendations.[20,21]

3. Results

The baseline clinical characteristics of the 63 (43 males and 20 females) patients studied at exacerbation are reported in Table 1 and compared with a control group (10 patients) of patients with chronic rhinosinusitis (7 males and 3 females) 4 of them were current smokers and 6 were non smokers and none of them ex-smokers. Subjects in the control group were similar to the exacerbation group as regards the sex and age distribution.

Subjects in the control population were of similar age and sex distribution to those of the exacerbation of COPD patients, but had a higher total nonsmokers and the total pack/year rate is lower, also the forced expiratory volume in the first second (FEV1) percentage of predicted and the FEV1/FVC ratio were higher in the control group, whereas the WBC counts, neutrophil percentage and CRP were higher in the exacerbation group.

3.1. Comparison between bacteria cultured from nasal swab and bronchoscopic lavage

The overall rate for aerobic Gram positive organisms cultured from the nasal swab was 49.2% and the aerobic Gram negative organisms was 34.9% and the remaining 15.9% anaerobes, in the BAL cultures the overall rate for aerobic Gram positive organisms 44.5% and 46% were aerobic Gram negative organisms and the remaining 9.5% were anaerobes.

The bacterial subtype that was retrieved in cultures from the nasal swab and bronchoscopic lavage was summarized in Fig. 1 and it showed that *S. pneumoniae* were cultured from 17 bronchoscopic lavage fluid compared with 16 samples of nasal swab (26.9% vs 25.3%) where as *S. aureus* was cultured from 11 bronchoscopic lavage samples compared to 15 nasal swab samples (17.4% vs 23.8%). The finding of higher *M. catarrhalis* cultures in 13 samples (20.6%), *Haemophilus infleunzae* cultures in 12 samples (19%) and *Pseudomonas aeruginosa* cultures in 4 samples (6.3%) from the bronchoscopic lavage compared to that of nasal swab samples 10 samples (15.8%), 9 samples (14.2%) and 3 samples, (4.7%) respectively. The nasal swab cultures showed a higher percentage of anaerobic growth in 10 samples (15.8%) compared to bronchoscopic lavage, 6 samples (9.5%).

In the control group (10 patients) there was no growth in 4 samples of the bronchoscopic lavage (40%) and 3 cases showed growth of nonpathogenic *Streptococcus viridians* (30%), 1 case of *S. pneumoniae* (10%) and 2 cases of *H. infleunzae*. The nasal swab of the control group showed growth in the 10 samples, 4 of them showed anaerobic growth (40%) and 3 cases showed *S. pneumoniae* (30%) 1 case of *M. catarrhalis* (10%) and 2 cases of *H. infleunzae* (20%) (see Fig. 2).

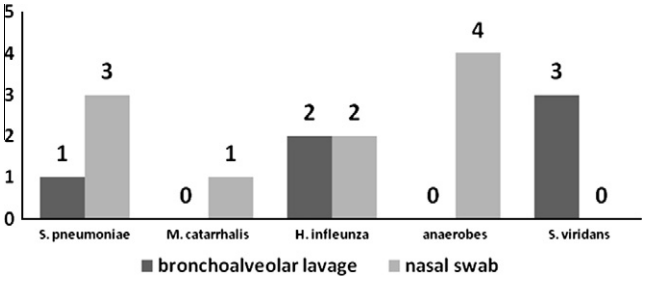

Figure 2 Comparison of organisms from nasal swab and bronchoscopic lavage in the control group (10 subjects), four subjects did not show bacterial growth in bronchoscopic lavage and three subjects revealed *S. viridians* nonpathogenic subtype, whereas all the nasal swab cultures showed pathogenic organisms.

3.2. Relationship between nasal swab and bronchoscopic lavage cultures

The nasal swab results were studied individually for the dominant organism and compared to results from the bronchoscopic lavage and there were 41 (65%) cases showing matched growth (i.e., similar organism subtypes was retrieved from both upper and lower airways) whereas 22 cases (35%) showed unmatched bacterial growth and the cultures from nasal swab and bronchoscopic lavage retrieved different organisms, Confidence Interval (CI) of the matched cultures was 0.52, in the control group there was no matching of bacterial growth in all samples (see Fig. 3).

3.3. The percentages of nasal swab organisms matched to BAL cultures

On comparing the results of culture between nasal swab and BAL for each patient; all the three cases of *P. aeruginosa* cultured from nasal swab (100%) were found to match to results of the BAL fluid whereas cases with nasal swab *S. pneumoniae* were 9 out of 16 cases (56.2%), *S. aureus* cases were 11 out of 15 (73.3%), *M. catarrhalis* cases were 8 out of 10 (80%), *H. infleunzae* cases were 7 out of 9 (77.7%) and anaerobes cases were 2 out of 10 cases (20%) (see Fig. 4).

4. Discussion

In this study, we performed middle meatal swab and bronchoalveolar lavage under local anesthesia on the same sitting for patients with chronic rhinosinusitis and concomitant chronic bronchitis exacerbation. Chronic obstructive pulmonary disease (COPD) is a condition characterized by an abnormal inflammatory response in the lung to noxious particles or gases. The exacerbation of COPD may also be associated with increased upper airway inflammation.[22] There is growing evidence of pan-airway involvement in chronic obstructive pulmonary disease.[23]

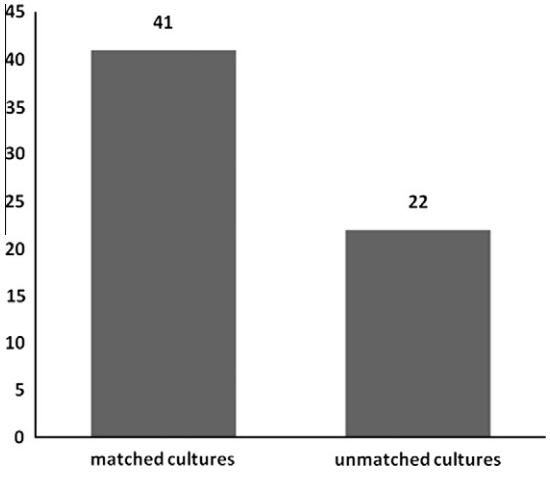

Figure 3 Comparison between the matched and unmatched bacterial growth in nasal swab and bronchoscopic lavage in chronic rhinosinusitis patients with COPD exacerbation. There was no matching growth between the nasal and bronchoscopic samples in the control group.

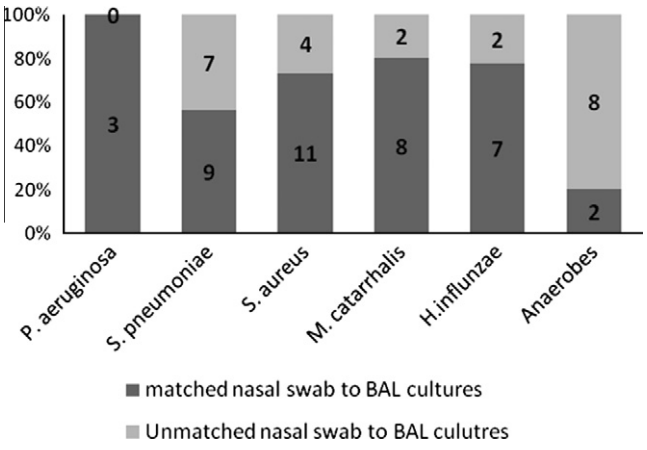

Figure 4 Percentages of matched pathogens cultured from nasal swab compared with lower respiratory pathogens retrieved from bronchoalveolar lavage. The column (100%) stands for the number of organisms cultured from the nasal swab; the darker color indicates the percentage of that cultured organism matched with BAL culture for each patient.

Kim and Rubin[23] in their review stated that concomitant sinonasal disease is probably under diagnosed and under treated in patients with COPD and they suggested that therapy directed toward treating the upper airway is likely to improve the health status of patients with lower airway disease. In addition, smokers who complain of nasal or sinus symptoms should always be evaluated for concomitant lower airway disease.[23]

We hypothesized the possibility of lower respiratory tract infection transmitted from the upper airway passages in patients with chronic rhinosinusitis.

With the current interest into the united airway disease and development of medications that target the infection in both sites, there is a need for clinically applicable procedure for obtaining samples for culture can be relied upon. This is the first study to simultaneously sample the upper airway through middle meatal swab, lower airway through bronchoscopic lavage at exacerbation of COPD.

In our study, the aerobic bacteria comprised the majority of both the nasal swab and BAL cultures (84.1% and 90.5%, respectively). There is higher percentage of anaerobes in the nasal swab specimens compared to BAL specimens. Initial studies by Frederick and Braude[24] in the 1970s implicated polymicrobial pathogens and emphasized the importance of anaerobes in paranasal sinuses cultures. More recent studies, however, have downplayed the role of anaerobes in paranasal sinuses culture results (anaerobes accounted for [less than] 6% of isolates in most series) and have implicated *Staphylococcus* and *Streptococcus* spp. as major pathogens.[25] Some of these authors have suggested that the inconsistencies in reporting are the result of variations in culture techniques and the fastidious nature of anaerobes. Aerobic organisms were 49.2% Gram positive in the nasal swab results and lower respiratory tract BAL were less (44.5%) meanwhile the Gram negative aerobic organisms in BAL culture were higher (46% compared to 34.9% in nasal swab results).

We used the method of endoscopic middle meatal swab as it gained increasing popularity, easy to perform, has low

associated morbidity and theoretically has reasonable correlation with antral puncture cultures which is relatively morbid, painful to the patient and is difficult for the clinician to perform in an outpatient setting.[26]

Our findings of a significant correlation between microbiological culture results from upper and lower airways in patients with concomitant chronic rhinosinusitis and COPD exacerbation provide new insight into the assessment of the sinonasal condition in COPD patients.

Hurst et al.[22] in their study on sputum examination and nasal wash concluded that a relationship between lower airway bacterial colonization and both higher nasal bacterial load and postnasal drip may suggest a possible mechanism for cross-talk between the upper and lower airways in COPD patients, although that study was conducted on sputum examination and it is not the optimum method to study the lower airway inflammation, and they did not examine the condition during the COPD exacerbation. Another study conducted by Hurst et al.[27] in another study on sputum and nasal wash during COPD exacerbation concluded that there was a relationship between upper and lower airway inflammation and COPD exacerbation is associated with pan-airway inflammation and he studied the bacterial load in both sites.

In our study we were concentrating on the microbiological relation of organisms that colonize the upper airways in chronic rhinosinuitis and its impact on acquisition of COPD exacerbation and we found that there was a matched growth between upper and lower airways verifying that there is a causal relation.

Ragab et al.[28] in their study on intubated patients with chronic rhinosinusitis and different types of airway diseases that did not include COPD exacerbation revealed that aerobic Gram-positive bacteria were the most commonly cultured bacteria (70%) in the middle meatus of CRS while our results showed that aerobic gram positive cultures in both the nasal swab and BAL cultures were 49.2% and 34.9%, respectively,

The result of matched bacterial growth in the upper and lower airways in our study (65%) was significant to support the hypothesis that the nose can be used to model the lung in COPD although the calculated 95% confidence interval (CI) for that matched group was 0.52 which may affect the sensitivity of the nasal swab as a diagnostic tool to predict the lower airway pathogens, which may be attributed to the small number of patients entered in this study as it was difficult to recruit larger group of patients during their acute exacerbation. It is recommended to try the study on a larger scale of patients to identify the validity of our results.

The matched growth of *P*. aeruginosa in nasal and BAL cultures points to the possibility of acquisition of the organism and the occurrence of exacerbation resulted from short term colonization of the lower respiratory tract rather than chronic colonization, while the unmatched percent in the anaerobic bacterial colonization was high.

5. Conclusion

Aerobic bacteria were the predominant organisms cultured from both upper and lower airways in chronic sinusitis patients with acute exacerbation of chronic bronchitis. There was observed matched pattern of microorganisms cultured concomitantly from upper and lower airways, although it did not reach high statistical significance, but may suggest that nasal swab may be used as a non-invasive tool to predict lower airway pathogens and recommending larger group study.

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